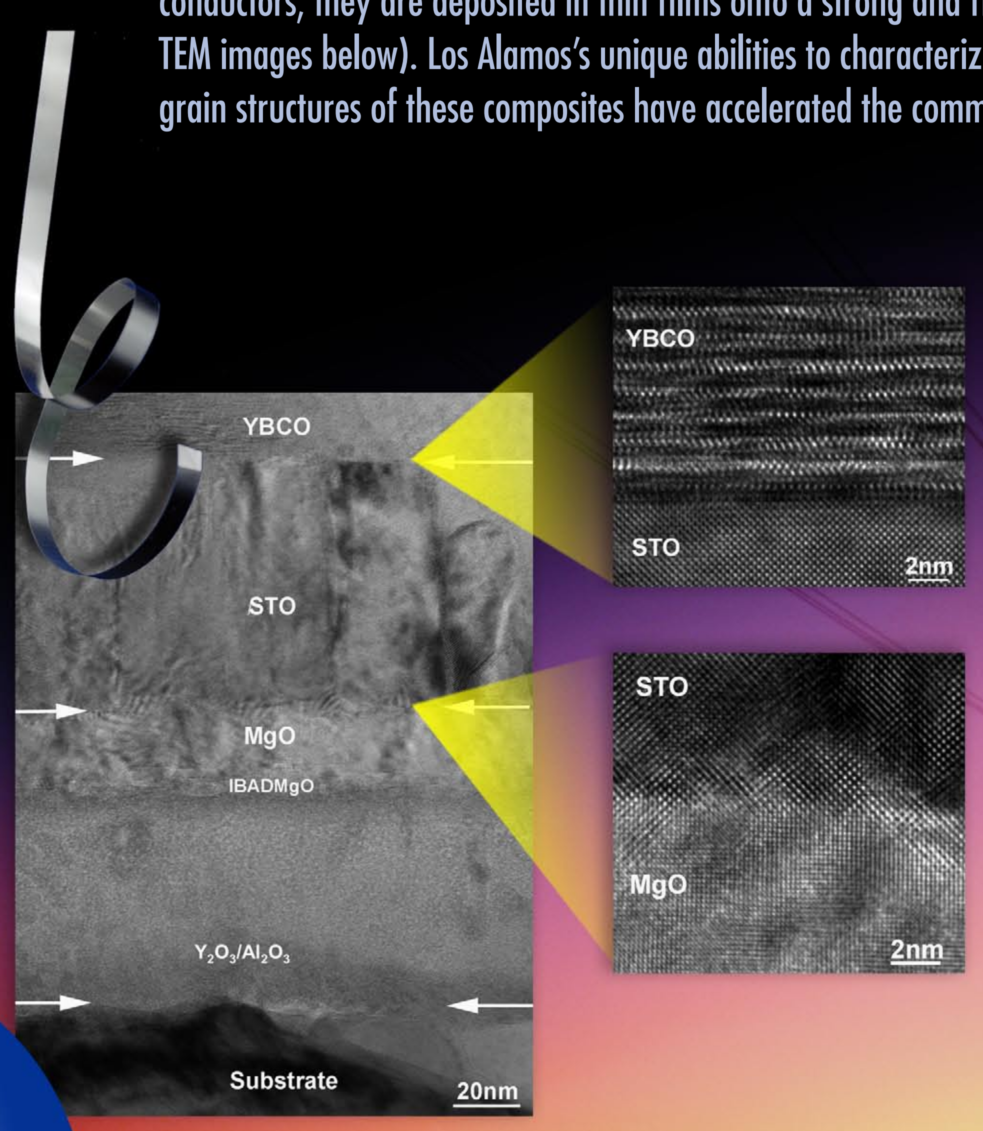
Nanotechnology and Energy Security

at Los Alamos National Laboratory

Superconductivity

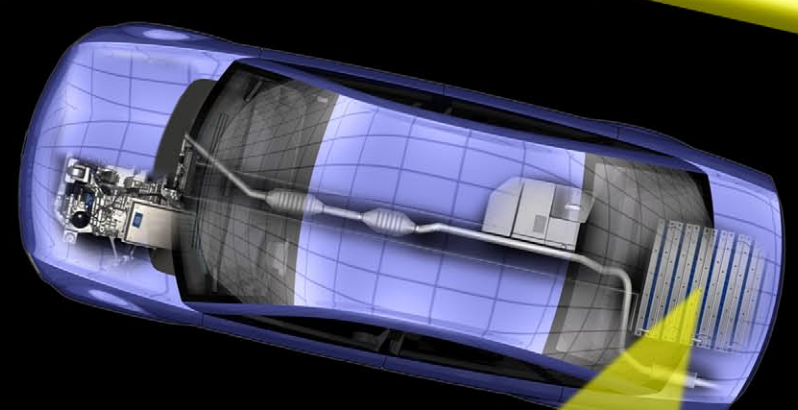
Superconductors, which have virtually zero electrical resistance, can carry 100 times more current than copper wires and could help the U.S. reclaim the 300 million kilowatt hours of electricity lost each year to the resistance of conventional conductors. The widespread deployment of superconducting transmission cables and equipment, such as generators, transformers, and fault current limiters, would reduce the amount of energy generated (and the resultant greenhouse gas emissions) and greatly enhance the security and reliability of the nation's electric grid. Because superconducting materials cannot be readily formed into practical conductors, they are deposited in thin films onto a strong and flexible metal substrate (see TEM images below). Los Alamos's unique abilities to characterize and manipulate the nanoscale grain structures of these composites have accelerated the commercialization of superconductors.

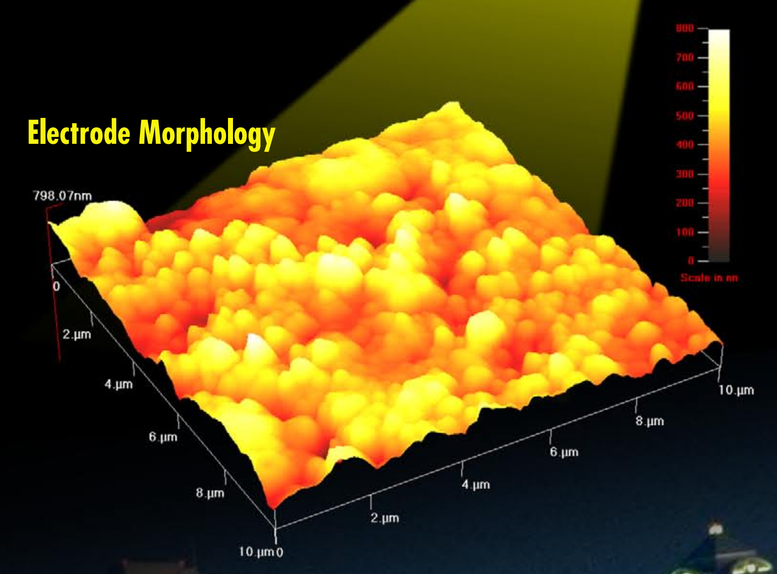


Hydrogen Fuel Cells

For over 25 years, Los Alamos has studied hydrogen fuel cells because they offer a clean, renewable, domestic energy alternative that could reduce pollution and decrease the nation's dependence on foreign oil. Our hydrogen and fuel cell researchers have made significant advances, but large technical hurdles remain.

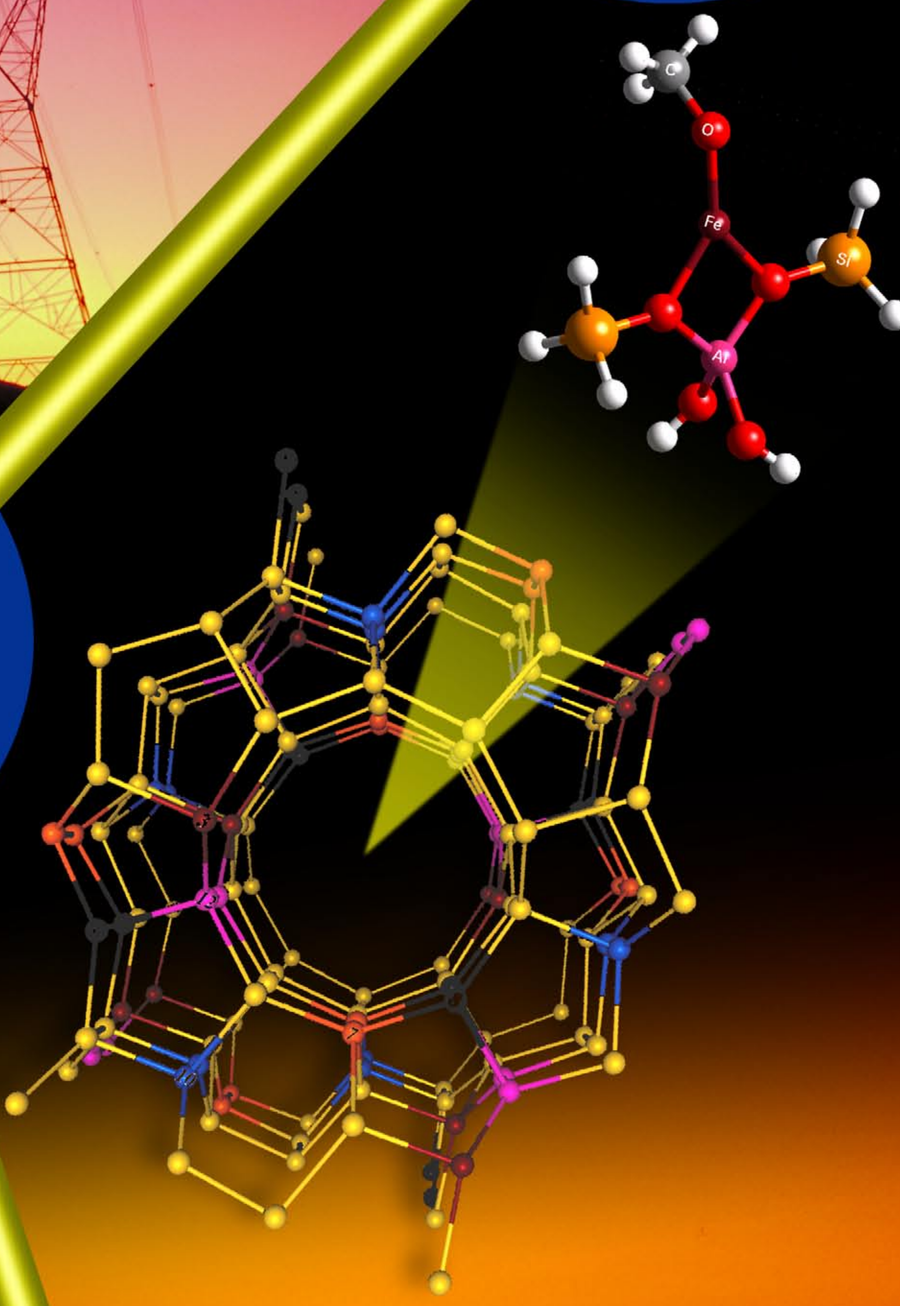
The key to overcoming these large hurdles is very small—at the nanoscale. Knowledge-based design and fabrication, controlled at the nanometer scale, of fuel cell electrode composites is critical to improving the performance, lowering the cost, and improving the durability of low-temperature fuel cells, all of which are necessary to enable their widespread use.





Catalysis

Among the many important applications of catalysis, perhaps the most important for the nation's energy security are the generation of fuels and the abatement of pollutants (NOx) generated by combustion engines and power plants. Los Alamos's scientists study two main classes of metal oxide catalysts: (1) site-isolated catalysts containing a single metal-oxo unit supported on a nanoporous scaffold; and (2) bulk oxide catalysts which are often complex mixtures of metal oxides. One important site-isolated catalyst contains widely dispersed iron oxo units encapsulated in a nanoporous silicate. This iron site is capable of inserting its oxygen into methane, forming bound methanol—a key step in converting methane to liquid fuels (see figure at left). Studies of the local structure of the iron and the iron-methoxy intermediate within the pore are performed using isotope synthesis and neutron scattering techniques to explore the influence of the local nanoscale structure surrounding the active site, which is critical to catalyst performance.



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